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Mesozoic Malevolence in *Jurassic Park*

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American Cinematographer

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American Cinematographer



From Suburbia to the Streets: *Amongst Friends*
Visual Effects Give Edge to *Cliffhanger*





JURASSIC PARK

When Dinosaurs Rule the Box Office

by Bob Fisher

You can't measure the expectations for the film version of *Jurassic Park* in ordinary terms, because the level of anticipation is way off the charts.

Countless millions of people have read Michael Crichton's bestselling book, in which scientifically created dinosaurs run amok on the grounds of a poorly planned theme park. Three million paperback copies were sold during the last few months alone. Most readers have al-

ready seen the movie in the theaters of their minds.

Industry entrepreneurs, meanwhile, are responding to *Jurassic Park* like a pack of tyrannosaurs tracking their dinner. At last count, more than 140 licenses had been issued to companies planning to merchandise everything from baseball caps and T-shirts to fast food and cereal. Keep in mind that this feeding frenzy took place before one

ticket had been sold.

Much of this unrestrained enthusiasm, of course, can be attributed to the public's enduring fascination with prehistoric creatures with tongue-twisting names. Many of us first learned about dinosaurs in preschool picture books. They are typically portrayed as benign, bumbling, downright lovable creatures. One of the most popular contemporary television characters, for example, is a



Photos by Murray Close

Above: Wealthy investor John Hammond (played by director Richard Attenborough, at left) learns the hard way that it can be unwise to fool with science. Right: Cundey (left) was offered the *Jurassic Park* assignment while he was working with Spielberg on *Hook*.

soft and cuddly tyrannosaurus named Barney, portrayed by an actor in a purple dinosaur suit. Most of Barney's fans are two to four years old, and they love him dearly.

But, like humans, dinosaurs came in all varieties, including some particularly vicious carnivores called velociraptors, which, in Crichton's tale, make the worst of Freddie Krueger's nightmares on Elm Street seem like pleasant daydreams. These nasty creatures are particularly well represented in the film.

The look of *Jurassic Park* is in familiar hands. Dean Cundey, ASC, had just finished shooting *Hook* for Steven Spielberg when the director asked if he was interested in translating Crichton's book into the language of film. Cundey had a pretty good idea of what to expect.

"Steven was involved with the script for maybe two or three years," he says. "He'd talk about it sometimes while I was shooting *Hook*. Production designer Rick Carter, with whom I had worked on *Back to the Future*, was already working on the sets. I got interested in what he was doing, the concept paintings and the research. While we were working on *Hook*, he'd come around with the latest drawings for Steven to look at or approve. I got involved as an observer very early in the project. Steven eventually asked



if I wanted to shoot the film after we finished *Hook*."

Cundey says that he and Spielberg tried to make the camera into another character in the film. The continuous movement and the choice of interesting and sometimes extreme angles generate a high level of emotional energy. This tactic is naturally intended to keep audience members white-knuckled and gripping the arms of their seats.

Describing a sequence in which the film's characters tour the dinosaur park in a tram, Cundey says, "It's like [the viewers] are along for the ride." People watching the film sway with the visual twists and turns, craning their necks as if they are looking for predators lurking in the shadows.

"This is a signature technique with Steven," Cundey says. "He brings the audience right into a character's face, so they can see what's in his or her eyes. It's a way of developing empathy. The camera is always moving, gradually getting closer to the point of danger."

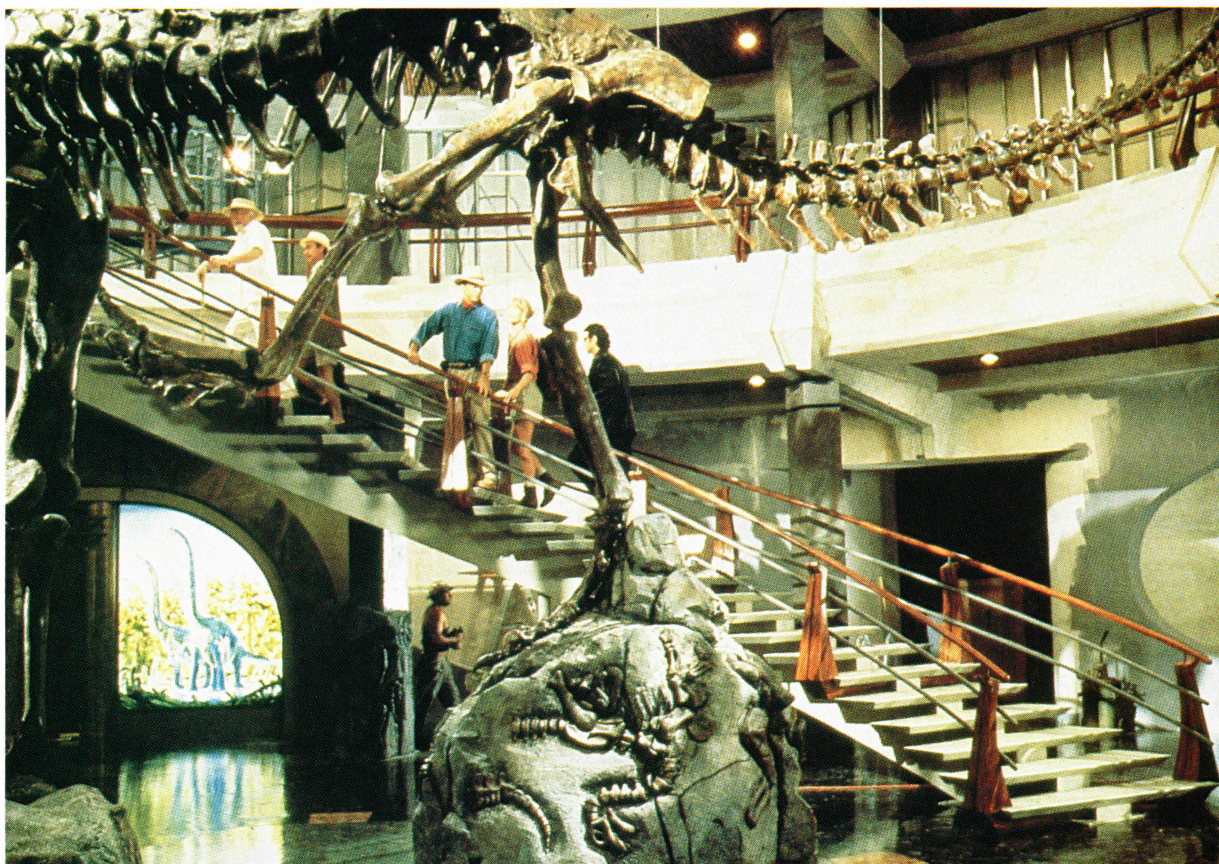
With *Jurassic Park*, Crichton, whose other novels-turned-films include *The Andromeda Strain* and the upcoming *Rising Sun*, crafted a vivid action-adventure story revolving around the themes of greed and science gone awry. In Crichton's tale, a rich investor builds a theme park set in the Jurassic Age on an island off the coast of Costa Rica. Instead of populating the park with make-believe dinosaurs, he commissions a scientist to clone the real things from DNA samples. In order to test the validity and safety of this experiment, the investor invites a few guests to visit the island before it opens. Naturally, prehistoric mayhem ensues.

Although *Jurassic Park* will feature accomplished actors Jeff Goldblum, Sam Neill and Laura Dern (as well as director Richard Attenborough as the island investor), the real stars of the show may well be mechanical

puppets and computer-generated-images (CGI). In order for the film to be believable, the digitally created dinosaurs have to blend seamlessly with the live-action footage. As those who have seen the creatures Godzilla, Rodan and Mothra in action can attest, the difference between a snicker and a gasp is slight.

Cundey's phone tends to ring when directors are making big-time visual effects films. He has already collaborated with Bob Zemeckis on five such films, including *Who Framed Roger Rabbit?*, the

Produced by
Kathleen Kennedy and Gerald R. Molen
Directed by Steven Spielberg
Director of photography,
Dean Cundey, ASC



Jurassic Park's creator takes his visitors on a tour of the premises.

Back to the Future trilogy, and *Death Becomes Her*. Cundey earned an Oscar nomination for *Roger Rabbit*, which smoothly integrated a cast of animated characters with live-action film. In *Hook*, Peter Pan flew with reckless abandon, thanks to the magic of digital compositing and wire removal.

Even with these experiences behind him, Cundey found that *Jurassic Park* presented a slew of technical questions. How do you light a mechanical puppet so it looks and feels real? How do you make the light falling on the digital creatures look as if it is motivated by believable sources? How does the compositing of digital characters affect the overall mood and texture of lighting, the way the camera moves, and the way images are composed? What about the shadows cast by digital characters?

"You have to visualize what it would look like if the creatures were there, and plan to shoot the film as though they were actors," Cundey says by way of answer. "ILM has done a fabulous job. It's not just wire animation with some texture mapping. They have stretched

and squashed the skin. There are moving wrinkles. There are details that you take for granted when you look at something in the real world. All of these things add to the illusion."

Cundey handled the casting of shadows in a variety of ways. Sometimes it was as simple as having a grip hold a flag or a cutout of the right shape in front of a light. These methods took some practice and had to be choreographed like a stage production, with the timing and angles executed perfectly. At other times, shadows were computer-generated and composited digitally.

"We usually made that decision on the spot," he says. "There is a quality to a real shadow that is difficult to replicate in a computer. But sometimes it wasn't possible because of the position and angle of light. So we asked the animators for help."

One of the Hollywood trade dailies recently dubbed Cundey "Hollywood's master effects lensman." He doesn't mind being stereotyped, however; after all, it's happened before. For a while, he was

categorized as a specialist in horror films. Then it was comedies. But the truth is that there is a world of difference between Cundey's other visual effects films and *Jurassic Park*. All of his previous films in the visual effects genre were wrapped in an aura of fantasy. The key to *Jurassic Park*, on the other hand, is hyper-reality.

"The audience has to believe the unbelievable," says Cundey. "You have to give them as much reality and recognizable truth as you can. They have to walk in the shoes of the characters. They have to feel the terror when the experiment goes wrong and a handful of people isolated on an island become prey for the dinosaurs."

Some of the predators are literally bigger than life, such as the mechanical tyrannosaurus, which towered 18 feet in the air. These oversized props translated into a lot of problem-solving. One important sequence, in which the visual perspective of the actors is simulated in a fairly extreme upwards angle, was shot on a stage. The angle meant that the stage ceiling would be in view. Ideally, Cundey would have simply blacked it out, but doing so would



Above: A tyrannosaurus rex takes stock of Dr. Alan Grant (Sam Neill) and Lex (Ariana Richards) as the pair huddle beside their overturned vehicle. **Right:** Dr. Ellie Sattler (Laura Dern) tries to discover a way to stave off a full-blown disaster at the park.

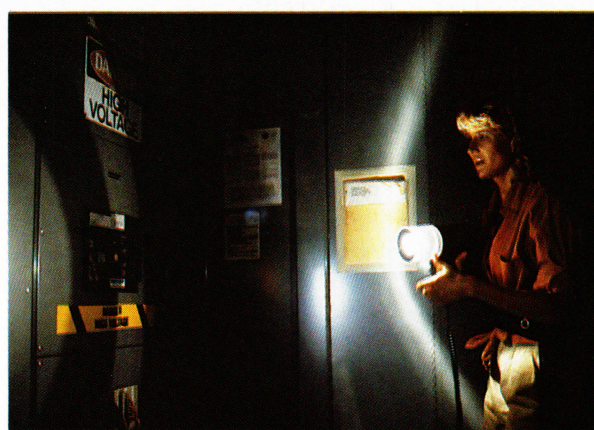
have given him some serious problems with the fire marshal.

"The grip department at Universal came up with some black louvers which we were able to funnel lights through," he says. "When we needed to, we could angle them to create a black background. At night, we opened them up, and that satisfied the requirements of the fire department."

One of the reasons Spielberg opted to shoot *Jurassic Park* in the Academy standard 1.85:1 aspect ratio, instead of wide-screen anamorphic, was to give visual emphasis to the huge size and bulk of the biggest dinosaurs.

"In *Hook* we had scenes with rows of people," Cundey says. "An anamorphic frame gave us the scope we needed to capture that side-to-side dimension. In *Jurassic Park*, you get a better sense of the sheer size of tyrannosaurus rex compared to the people in the 1.85:1 format." The large amount of digital compositing in the film was another convincing reason to stick with the smaller image area.

In addition to his big-budget effects films, there are other frames of reference in Cundey's career for *Jurassic Park*. *Halloween*, his breakthrough film with John Carpenter, and *Escape from New York* are among a series of features he shot



during the late '70s and early '80s which helped define a genre of reality-based horror movies made on shoestring budgets. Those films relied heavily upon the power of the images in evoking emotions in audience members.

It's not a new idea. "I heard it first from James Wong Howe [ASC] when he was about 70 years old," Cundey recalls. Howe was teaching a class at UCLA while he was preparing to shoot *The Molly McGuires*. Cundey was a student with a split major in film and architecture. After class, Howe would move to a nearby coffee shop, where he talked with some of the students. "He said as he got older, he learned to simplify by working with less light. I always remembered that

when I was being challenged to do more with less. [Low-budget films] taught me to think about how to solve lighting problems without making things more complicated. I learned how to improve a scene by subtracting light, and how I could get two or three shots out of one setup."

That method is apparent in *Jurassic Park*, where shadows are used to conceal just as light is used to reveal. It's one key to the feeling of anticipation which builds throughout the film. "I think he [Spielberg] used the dinosaurs very wisely," Cundey says. "He shows just little quick pieces of them in the beginning. There is a sense of mystery, and gradually we reveal more and more."

"The idea is to show enough for the audience to understand the moment," Cundey says. "But not so much so that they are sitting there trying to figure out how we did it."

In terms of showing effects, how long is too long? "It's getting longer, because the effects are getting more sophisticated," Cundey points out. "But so is the audience, at least on a subconscious level." In other words, there are no

rules that you could put into a textbook with impunity. Success is ultimately based upon the filmmaker's innate instincts.

Cundey is a bit more resolute, though, when he notes that a film's characters are of the utmost importance. If viewers don't care about the characters, they won't care if a few of them become lunch for a hungry velociraptor.

The cameraman further credits his low-budget film days with teaching him that there is more to cinematography than artistry and craftsmanship. He learned how to get along with the cast and how to organize and motivate his crew to give him a little more than they thought they had.

"I don't care what the bud-

get is, if you don't have good chemistry, you can't make a good film," he insists. His camera operator, Ray Stella, SOC, has been with him for 18 years. Others have been on his crew for 15 years, and even the newest people have been working together for seven or eight years.

Jurassic Park represents a logistical triumph. Production stretched over some six months of original photography, mainly on four big soundstages at Universal Studios. The stages were packed with elegantly detailed sets, from the control room at the park to the elaborate jungle exteriors.

"We shot many of the jungle night exteriors, visual effects and action sequences on stages, because it was easier to control lighting," Cundey says. The interiors were mainly captured on the 500-speed Eastman EXR 5296 film. The big daylight exteriors, designed to give the audience a sense of the scope of the park, were filmed on Kauai, which doubled for the island which served as the book's setting.

These exteriors provide an interesting example of how the art and craft of filmmaking converge. In *Back to the Future III*, Cundey opted to shoot daylight exteriors with the Eastman EXR 50-speed daylight film. He knew he would be shooting in bright sunlight and he wanted the richest possible imagery, with deeply saturated colors devoid of the slightest hint of grain. In *Jurassic Park*, however, there are daylight scenes in which the audience gets glimpses of one or more dinosaurs in the background. The latter has to be in sharp focus, because the image of the dinosaur is going to draw the audience's eye to that area of the frame.

Cundey never knew when clouds would float by and block the sun, creating dark shadows. He anticipated shifts in sunlight by using the 100-speed EXR 5248 film to photograph exteriors, because it gave him the edge he needed to pull a deeper stop, usually within the range of T2.8 to 4.

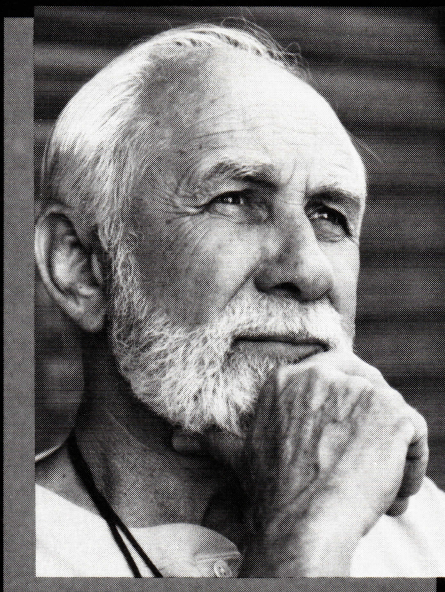
"Steven likes to storyboard," Cundey says. "It helps organize his thinking." At the same time, Spielberg is an intuitive director who will often modify or throw away the blueprint at the moment of photography. Not this time. "He stuck

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On Location in The Blue Hole

Any filmmaker will tell you that finding the right location can be as critical to a film's success as casting. When your film happens to be called *Jurassic Park*, finding the perfect location doubly crucial, since the would-be amusement park is, in many ways, the film's grandest character. But no one knew going in just how great an adventure shooting *Jurassic Park* would become.

Steven Spielberg was already familiar with the Hawaiian island of Kauai, where he'd shot several background plates for his last cinematic foray, *Hook*. Still, convincing the filmmaker to bring one of the largest scale productions in cinema history on location to Hawaii took some doing. "Steven Spielberg worked with my predecessor for a period of two years while they were discussing filming *Hook* here," says Kauai Film Commissioner Judy Drosd. "Even though the relationship was formed prior to doing *Jurassic Park*, there was a long period of discussion before they came to look at locations, and they visited many times before they decided to film here.

"Our office is here to help people find the locations they want, and to make their experience trouble-free," Drosd explains. "In this case, they knew what they needed, so I suggested a number of places they should consider, and also worked with them to make sure their shooting permits were in order and that they had all the contacts they needed. When a company of that size moves in, there are a billion questions, so we become Information Central."

One of the places Drosd had suggested was the area of Kauai called The Blue Hole. Spielberg and company were familiar with the area, which is considered one of the most beautiful regions on earth. "The Blue Hole is the deepest part of the Waialeale crater, the major volcanic area on Kauai, which is extinct," Drosd says. "There's a wall of waterfalls that flows over the crater into the riverbed below, and that's called Blue Hole. Looking through the gates of *Jurassic Park*, you're looking at the Waialeale crater."

The Blue Hole locations were among the most remote on the island, and sometimes the *Jurassic Park* crew were even out of cellular phone communication, which meant

the Film Commission office had to keep track of their location in case of emergency — like the huge hurricane that whipped across Kauai on the final day of their sixteen-day schedule.

Preparing for the storm became the crew's major focus Thursday night. The hurricane hit around 11:00 on Friday morning. "It's an irony, because *Jurassic Park* also involves a massive impending storm that finally hits!" Drosd observes. "After the storm had passed, the film crew used their chainsaws and power tools to clear the entire road from the hotel they were staying in, the Kauai Westin Lagoons, to the airport, and made it possible for people to leave the hotel."

A series of remarkable events ensued. "Everything was down — there was no power, no water and no communications," Drosd says wryly, "so one of the producers, Kathleen Kennedy, who is a marathon runner, ran to the airport and tried to charter a plane to get the crew out. When she was told that no planes were landing or leaving because they needed to have the entire runway secured for provisions, she asked what provisions they needed, then hitched a ride on an army transport helicopter to Oahu, 90 miles away! Once there, she got on a telephone and bought the contents of two Safeway stores, chartered a Hawaiian Airlines jet and brought it all over to Kauai. She then gave the provisions to Kauai and got her crew out, as well as any other people from the hotel who could fit!"

As things turned out, Spielberg and his principal players caught an army transport out on Saturday night, while the rest of crew took off Sunday night, thanks to Kennedy's efforts. "They only missed one day of shooting on the backlot," Drosd points out.

In the six months since the hurricane, Kauai has made a miraculous recovery. Much of the lush vegetation that was uprooted by the storm's fury has grown back, and the people are getting their lives back on track. "The place looks beautiful, a number of hotels are open and available and there are lots of places to shoot in," Drosd smiles. "In fact, Rob Reiner will be here this summer to shoot his feature film *North*."

— Ron Magid

pretty close to the boards because of the schedule, and because we were going to be doing so much digital compositing."

Cundey shot most of the plates for scenes destined for digital compositing in the VistaVision format, using VistaFlex camera ILM developed for *Roger Rabbit*. "You usually work with a larger format camera for plate work, because you inevitably lose some image quality as you go through each generation of optical compositing," he says.

"However, since compositing was done digitally at ILM, it gave us the opportunity to try something new. I shot some of the outside exterior plates in 35mm film format using the 5245 film. That saved us some precious time. The image quality was pristine, and the composites made with the 35mm film plates are transparent."

From the beginning, Cundey says, everyone on the project was in touch with the fact that the audience is going to have their eyes on the dinosaurs.

"I don't think you can fool them with people in rubber suits, or conventional stop-motion," Cundey says. "Audiences have become too sophisticated to be fooled by our old tricks. But I think they are going to be startled. It's not just the digital dinosaurs. The mechanical puppets are the best I've seen. The 18-foot tyrannosaurus rex is based on the same flight simulator used for training F-14 pilots. It's all computer-controlled, with very sophisticated hydraulics. Its movements are so realistic that it is easy to start feeling like you are out there with a real dinosaur."

Even with top-notch props, however, the ultimate success of a project boils down to capturing the action on film. Except for some action sequences, where Cundey used a second camera for coverage, *Jurassic Park* was a one-camera shoot. He used a Panaflex Platinum camera with Primo lenses for interiors, and usually a Primo zoom for variable focus on exteriors. No diffusion or filters were used to alter the quality of the image. The movie has a straightforward, clean look which Cundey describes as "heightened reality."

"Steven believes in visual storytelling," Cundey says. "He un-

derstands the importance of setting the mood with light and creating arresting images for the audience. That made it easy for me to say, 'It would look really interesting if all the light came through that window, and the guy is in silhouette, and then he steps into a pool of light.' You can say something like that, and he understands exactly why. Other times, he'll come up to you and describe a look he wants to see."

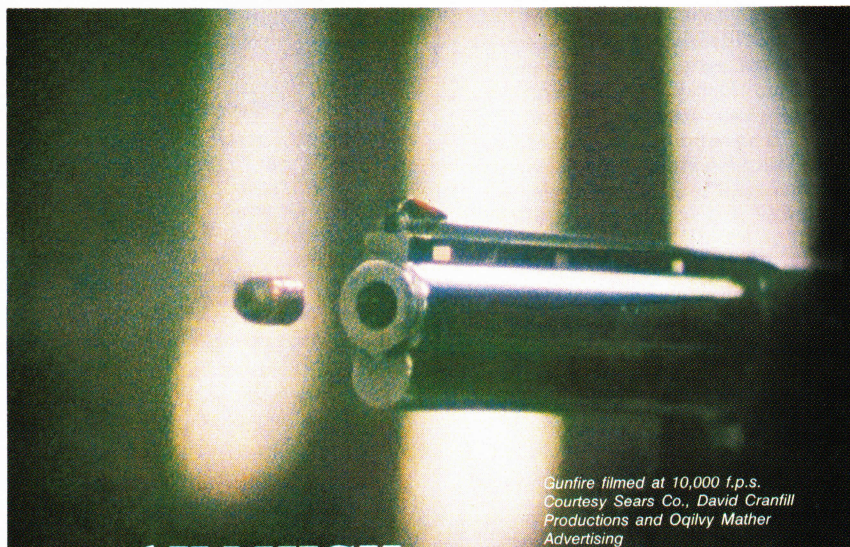
In one sequence, the characters portrayed by Attenborough, Neill, Dern and Goldblum have retreated to a bunker which had been built in case of a mishap. Spielberg wanted a dramatic look, dark but still in daylight. "We decided that all of the light sources should come from some very small windows," Cundey says. "We looked for angles where we could backlight. We put a little smoke in the room. That allows the audience to see shafts of warm light slicing through the darkness. Once we did that, we were able to block the scene and move the actors around. We framed a window between two people, and used some rim light. It's a very dramatic setting which helps establish the mood. The characters realize that everything has gone wrong, and they have to come to terms with that reality."

Cundey used just about every device there is for holding and moving cameras, including tripods, camera cars, PeeWee and Fisher dollies, a Chapman crane, a Steadicam and a Matthews crane with a Cam-Remote head. "I used the Cam-Remote a lot to put the camera in places we couldn't get to with a regular dolly," he says.

That same versatility applied to the lighting. Just a few years ago, Musco lights were revolutionary. On *Jurassic Park*, Cundey used just about all of the mobile lighting tools available, including Night Sun and Night Light, for both daylight and night exteriors on the jungle set and in Hawaii.

"We had a big 20K incandescent light," he says. "It gave us a single source, and a single shadow. It gave us a believable source of sunlight, which meant that we didn't have to open up the camera lens too much. So we were pulling a deeper stop. Those are all of the things which tell the audience at some subcon-

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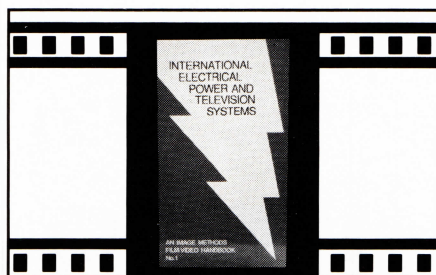
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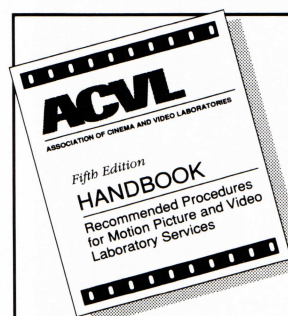


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Dr. Grant, Lex and Tim (Joseph Mazzello) take refuge from their prehistoric pursuers.

scious level whether you are really outside or not."

Cundey also made occasional use of the new slant-focus Panavision lens, which can be adjusted to move the field of focus from side-to-side to front-to-back. "We used to have to struggle with a split diopter in front of the lens, to hold focus from the foreground to the background," he says. "This lens makes it a lot easier." The slant-focus work can be seen in a brief scene in which one of the film's two youngsters occupies the foreground while a dinosaur looms in the background. Cundey wanted to hold them both in crisp focus to make the threat more immediate and menacing. If one of the figures had gone soft, the feeling of imminent danger would have been weakened.

In another scene, Cundey used the slant-focus lens to show a character working at a computer console. He wanted the actor in sharp focus, with all of the labels on the console readable. "It helps the audience understand a key story point," he explains. These aren't the types of shots that movie critics write about. They tend to be taken with landscapes, sunrises and sunsets. But it is this attention to detail that draws the audience into a film, and keeps them involved in the story.

"One of the things which intrigues me about filmmaking is the ability it gives you to create an illu-

sion by getting the audience to believe something you have invented," says Cundey. "It must be the same for actors, writers and directors. I don't mind being stereotyped, because right now, I'm enjoying the films I'm shooting. But I'll admit, there are times when I dream about shooting a film with two actors in one room." ▲

Things to Come . . .

Additional aspects of the making of *Jurassic Park* will be examined in upcoming issues of *American Cinematographer*.

Also coming soon to *American Cinematographer*:

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AC will also cover new films from D.A. Pennebaker and Frederick Wiseman.

Effects Team Brings Dinosaurs Back from Extinction

by Ron Magid



The jeep heads right for us, the driver so terrified he smashes into a log, shearing the windows and the seat backs clean off as the jeep skids under, spinning almost out of control. A roar echoes from the dense grove behind the jeep; trees shudder, toppling down, crushed by some monstrous weight. Then it appears, its vast body supported by two powerful legs, its voracious jaws filled with teeth the size of daggers — a living tyrannosaurus rex. The huge reptile comes after the jeep, careening through the log, reducing it to kindling, then crashes into the jeep, denting its side and upending it into the mud. The driver and his companion stumble from the wreckage as the fearsome beast, more terrifying than any dragon of legend, chases them deep into the dense jungle of Juras-

sic Park.

This startling sequence, filmed in a single breathless shot, is one of dozens of collaborations between full-scale dinosaur creator Stan Winston and mechanical effects supervisor Michael Lantieri on Steven Spielberg's long-awaited adventure epic. Along with stop-motion animator Phil Tippett and ILM visual-effects supervisor Dennis Muren (whose contributions to this and other sequences will be detailed in the next issue of *AC*), Lantieri and Winston round out *Jurassic Park*'s revolutionary dinosaur-design team. Using every known effects technique, and some they created out of necessity specifically for *Jurassic Park*, these men may well have done the impossible: given convincing life to an unholy menagerie of creatures who haven't walked the earth in mil-

lions of years. It is an achievement that may well change forever the way we look at effects films.

Lantieri and Winston's work was used almost exclusively for the live-action dinosaur effects during principal photography. Together, they helped one another solve problems that have plagued effects men like Willis O'Brien from the prehistoric era of cinematic illusion (the silent *The Lost Continent*, the legendary *King Kong*) to the present day. "We really worked as one crew," Lantieri marvels. "Early on, our four-man design team took this pie, which represented all of the special effects in *Jurassic Park*, and cut it up. We figured who could best do each effect, and then one or the other would say, 'We can go so far with this; can you pick up from here and run with it?'"

In the beginning there was Stan Winston. As the multi-Academy Award-winning makeup effects artist will tell you, every dinosaur created for *Jurassic Park* began on the drawing boards at his Stan Winston Studio in Van Nuys. The bearded makeup impresario is a cagey fox, dazzling his audience with reams of techno-jargon, but the man has undeniably produced some of the most remarkable creations in screen history: the alien queen of *Aliens*, the *Pumpkinhead* demon (from the film he also directed), the robotic cyborg of *The Terminator* and the shape-shifting T-1000 in *Terminator 2*.

What gives Winston's mechanical marvels their edge seems to be a philosophy stemming from his own humble beginnings as a struggling actor who fell into the field he now dominates almost by accident. "I got involved in a makeup apprenticeship program while I was waiting to be a star," he admits. "I was a big Lon Chaney fan and I was inspired by him to create wonderful, bizarre and incredible fantasy and real characters for film. When I realized a prosthetic makeup on an actor's face wouldn't allow me to fully realize the characters I was asked to create, I began using special effects technology to create fantasy characters that were completely animatronic puppets. I haven't gone from makeup to special effects; I have increased my palette with more colors that allow me to create characters using all the technology available, be it a makeup, a prosthetic, or dinosaurs for *Jurassic Park*." Unlike others in Winston's field, he sees his creations as characters who have to perform, on cue, like any other actor. This makes his task more demanding, and more rewarding.

One and a half of Winston's two years on *Jurassic Park* were spent designing the creatures who populate fictional billionaire John Hammond's bizarre island amusement park. All told, Winston's crew visualized nine different species of dinosaurs, most prominent of which were two-legged predators such as the tyrannosaurus rex, velociraptors, and "spitters," along with four-footed vegetarians such as triceratops and the mammoth brachiosaurus. "Steven felt that there should be a consistent dinosaur design," Winston explains, "so even dino-

saurs that were only realized in the computer at ILM, such as the ostrich-like gallimimus were designed here. The approach is very simple and it's what we do on every project: artistically, everything starts on the drawing boards. We're certainly not going to throw two tons of clay at an armature and start sculpting a full-sized tyrannosaurus rex and hope that it looks great! On *Jurassic Park*, our concept artist was Mark 'Crash' McCreary, who did all the final renderings of the dinosaurs. The creatures' skin coloring was created by Shane Mahan and John Rosengrant, among many others."

Once the designs were finalized on paper, Winston's crew created 1/5-scale sculptures of each dinosaur, except for the brachiosaurus, which was so huge in life that Winston opted to do him as a 1/10-scale model. These clay maquettes were molded, cast in fiberglass and painted not only to show Spielberg what the creatures would look like in three dimensions, but also to serve as the models for the computer-generated dinosaur effects created by Phil Tippett in conjunction with ILM and Dennis Muren. Winston's crew also fabricated 1/5-scale mechanical versions of each character destined to become a full-scale animatronic puppet.

Winston says it was a brainstorm in the middle of the night that led him to devise a system for exactly translating his miniature dinosaurs into their full-scale counterparts: using cross-sections taken at precise intervals from his 1/5-scale dinosaurs,

he had them blown up five times and made into wooden patterns which were then strung along metal spines. "We covered the wooden patterns with fiberglass to create a smooth solid surface, then started putting clay on it to make our finished sculpture," Winston boasts, "and that became our sculpting armature. It ended up looking exactly like a very large version of those wooden dinosaur skeleton toys you can buy! The form of the dinosaur was done virtually by mechanical drawing, so our full-scale creations were identical to our 1/5-scale maquettes. All we had to do then was to sculpt the skin and the detail. Later I learned this was exactly the way the Statue of Liberty was built!"

Each of the full-scale dinosaurs, which included the tyrannosaurus rex, the spitters, the velociraptors, a triceratops and an insert brachiosaurus head and neck, took teams of sculptors months to craft to Winston and Spielberg's satisfaction. The sculptures were then molded, and from these molds flexible skins were cast which were then fitted over graphite and metal skeletons laden with all manner of mechanical devices: air bladders to simulate breathing, cable-actuated systems to perform certain body movements, radio-controlled servo motors to control facial motion. The creatures were all designed to operate in real time.

Meanwhile, mechanical effects supervisor Michael Lantieri was hard at work creating what the four-man design team laughingly called 'dinosaur interfaces,' mechanical sys-



Opposite: John Hammond (Richard Attenborough) helps a baby dinosaur out of its shell as Dr. Ellie Sattler (Laura Dern) and Dr. Alan Grant (Sam Neill) observe with amazement. This page: Tim (Joseph Mazzello) encounters a sick triceratops in the fields of *Jurassic Park*.



Perched high up in a Jurassic Park tree, Tim and Lex (Ariana Richards) help Dr. Grant feed a friendly brachiosaur.

tems that would help these full-scale behemoths to stand, walk and perform in scenes. "We always joked that Stan got the glamorous end of it," Lantieri grins, "but the behind-the-camera work turned out to be really important and Stan was great about including us. We really worked together. If he'd made a creature that was only there from the waist up, we built out of our special 'dinosaur interface' things that could be attached to the creature to move it. Stan and I talked about where we could attach our interfaces, how we would move them and the speed [we would use]. We built a lot of different rigs that would accommodate Stan's puppeteers, underground cranes and dollies, as well as pneumatic cranes that would assist with the broad movements. In addition, my guys would be involved in the shoving and pushing needed to give the full range of motion."

Of all the life-size dinosaurs, the velociraptors embody the most controversial blending of techniques: at the core of several of the various effects models are human beings. Given the dubious legacy of el cheapo productions such as *Unknown Island*, *The Land Unknown*, and Japan's legendary contribution to the genre, the *Godzilla* series, the idea of man-in-a-suit dinosaurs has been reviled by cinéastes from time immemorial. Today, the man-in-a-suit ap-

proach has become state-of-the-art, and Winston is almost singlehandedly responsible for the public's dramatic change in attitude. "If there was a man inside a dinosaur, there was a great deal of technology inside that dinosaur, too," Winston observes.

"For *Jurassic Park*, we designed and built full-sized, performing, live-action dinosaurs. The methods we used involved whatever technology was required to create the performance needed. We built two man-in-suit raptors and two fully animatronic, no-human-being puppet raptors utilizing a combination of cable and servo control. We also made a set of walking legs and a set of running legs from the waist down. For certain shots, we created insert hands which could, for example, open doors. Then we fabricated our stunt raptors, full-sized floppy puppets and poseable puppets. All told, we built eight to ten full-sized raptors that did different things. We also built a baby raptor splitting out of its shell, which was totally real-time using cable control."

Winston's goal was to create fluid, believable dinosaurs that bore no trace of the mechanics which gave them life. Specifically, he wanted to conquer the phenomenon he refers to as "waga-waga," which he scientifically defines as the jolt that occurs when a large moving mass

comes to a stop. Such jolts, which mimes employ to simulate robotic movement, work fine for machines like the Terminator, but they would have seriously undermined Winston's attempt to bring his dinosaurs to convincing life. Through the careful application of some unusual, though strangely related technologies, the raptors and some of Winston's other dinosaur creations, most dramatically the full-scale tyrannosaurus rex, employed a breakthrough "anti-waga" system. They were dubbed "Steadi-Dinos" because their movements were based on neutral buoyancy, the same principal which is integral to the Steadicam. This concept was envisioned by Craig Caton, one of Winston's key mechanical designers.

"I saw the relationship between a person having a hard time trying to hold a camera at the end of his arm and the need to hold up a head mechanically on a long neck," Winston beams, "and I realized that the same wonderful system of counterspringing the camera so the weight load becomes neutral could help us mechanically. We realized that this could work very well for us in terms of certain head and neck movements, to make everything fluid. The actual infrastructures of our dinosaurs were countersprung just like a Steadicam, which made our creatures' movements totally fluid and organic. That technology went into the spitters and the velociraptors, two of our most active dinosaurs."

But this system achieved its most remarkable results in *Jurassic Park*'s star attraction, a 40-foot-long, 9000-pound animatronic machine that perfectly recreated the appearance and fluid motion of a full-sized tyrannosaurus rex. "The technology of the T-rex is beyond anything I think anybody has ever seen," Winston says. "One of our big problems was figuring out how to make this 40-foot-long creature move quickly and violently, perform wonderfully, yet come to a smooth stop on cue without the waga-waga you would expect. We solved the problem through a series of computer-involved aspects of ramping up and ramping down speed, and by building accelerometers into our anti-waga devices. A series of accelerometers enabled us to measure the

speed of the hydraulic rams moving within our dinosaur, which allowed us to counter that movement with other rams moving in the opposite direction elsewhere in the body. So our T-rex never completed a particular move and stopped without another aspect of the body compensating immediately. In order to keep this creature moving with speed and dynamics, nothing was allowed to come to a hard stop against its rigid 9000 pounds without something else counterbalancing that motion. When its head comes to a sudden stop, something moves in the neck to compensate for it at that exact split second, which acts as a shock absorber. It's wonderful how this guy performs — he's fast and big and dangerous and he's a great actor."

Winston was concerned that the T-rex, weighing in at 9000 pounds, was potentially as lethal off-camera as on, and he began to worry about how to control this gigantic performer so it would interact on cue with its environment and not present a safety hazard. "Unlike any other hydraulic creature you've seen in an amusement park, say King Kong, whose specific moves have been programmed in over a long period of time and who repeats those movements over and over, our tyrannosaurus rex was this big hydraulic machine that had to perform on cue," Winston states. "When you're an actor in a film, you have to be able to take direction immediately, so I was concerned about how to coordinate the computer keyboards with eight or ten people on them to make these big moves. The biggest problem we had beyond all this technology was safety. There's a real big danger factor working on a set with a 9000-pound machine. This dinosaur could've killed someone really easily."

As with many of Winston's best ideas, the ideal solution to this hazard presented itself in the middle of the night. Winston had worked with performance Waldos many times before, but these telemetry suits, which translate the motion of the person wearing them into the performance of the mechanical creature itself, were designed for more humanoid characters. No one had ever devised a telemetry system for creatures that didn't mimic human motion. "Thinking back to our 1/5-

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scale mechanical T-rex prototype, I had the brainstorm that we could actually use one similar to it as our telemetry puppet!" Winston grins. "I realized that we could literally build a performance Waldo for the T-rex that duplicated every motion he made in 1/5 scale, and use that as an interface for us to organically puppet the creature. Instead of having linear potentiometers linked to a control board, each potentiometer would correspond to a cylinder in our puppet version of the T-rex, so we had a 9000-pound puppet that was literally operated by puppeteers manipulating a small version. That way, Steven could say, 'Let him rear up' and we could pull our 1/5-scale Waldo back and let him act; our full-scale T-rex performed on the spot. If a situation required a really critical move, we could puppet it on the fly, and then, using the computer system that controlled our T-rex, we could record that move and repeat it over and over again at the push of a button."

The animatronic tyrannosaurus rex was actually built in two parts. The upper body from head to tail down to the knee made up one section, while the legs comprised the other. The two sections could appear to be one creature by strategically placing a tree branch across the join; there was also a set of dummy legs that could be positioned under the mechanical upper body. The effects team also constructed a foresection of the T-rex consisting of the front half of his body, which at 4000 pounds was easier to move around than the full 9000-pound version.

The gross movements of the nose to tail T-rex's massive upper body were controlled via a motion platform Winston calls the "Dino-Simulator" because of its similarities to a flight simulator, a hydraulically actuated, computer-operated platform capable of handling all six axes of movement smoothly, even while bearing an enormous weightload. Winston stresses that the full scale T-rex's articulation was tied directly into the flight-simulator concept. "We took that same technology and, like branches on a tree, moved it right out to the tip of its nose," he says. "The basis for the hydraulics and the mechanics and the fluidity of the T-rex's movement was the methodology behind flight simulators. The Dino-Simulator could fluidly move

the creature forward, back, from side to side, and up and down. We took that system and continued to work up into the beast with hydraulic cylinders, transducers, and the addition of accelerometers, so what worked the Dino-Simulator also moved the entire dinosaur. Our problem was that it wasn't enough for the T-rex to move fluidly; it had to perform, so we had to take another step because now we had a longload-bearing situation that was setting itself up for an amazing waga! The solution involved computer cards to rapidly ramp-up and ramp-down speed, combined with counter-moves to stop the waga."

Assisting with the construction of the Dino-Simulator was only the tip of the T-rex for veteran floor effects specialist Lantieri, who gives off the impression of a youthful elf with enormous enthusiasm for the problem-solving that comprises most of his work. It's hard to believe he got his start some 20 years ago handling effects for *The Six-Million-Dollar Man* series at Universal Studios, where he now works his magic from his permanent, Spielberg-funded workspace on the lot. Along the way, Lantieri has won two Academy Award nominations and three British Academy Awards for his ability to contribute invisible expertise to such landmark productions as *Who Framed Roger Rabbit?* and the *Back To The Future* films.

Even with all of this experience, however, Lantieri had never faced problems like those confronting him on *Jurassic Park*: "Once you bring a dinosaur in for a shot, then what do you do with it? Not only did we have to move our creatures within the shot, we had to move them into position for the next setup. We had to be able to turn them around and move them out of the way. This meant we had to build very dinosaur-friendly sets to accommodate our winches and cranes and air bearings, most of which helped move the creatures into position and also, for certain shots, handled some of their broad movements in conjunction with Stan's puppeteers.

"We literally built a walker with training wheels to move the full set of T-rex legs. We also mounted the Dino-Simulator onto a tower that I built which was on air bearings, so we could use high-pressure air to

glide a great deal of weight. Air bearings are used for moving heavy equipment out in the real world, but we use it for simulating earthquakes and other effects where we move big, heavy objects."

Such as 9000-pound dinosaurs. This concept brings us back to the aforementioned shot in which the tyrannosaurus rex wreaks havoc on a jeep. "The T-rex was supposed to give chase, run through a grove of trees, break through a gigantic log that's fallen across the road, then slam into the jeep," Lantieri smiles, pausing to catching his breath. "Naturally, Steven wanted it in one shot. Upon the action cue, we were controlling half a dozen large real trees that had to be mowed down in sequence before we even see the T-rex. Each tree had to be scored, precut and hinged using internal cables, as well as cables on a pulley at a 45-degree angle. We set off sequential charges in the trees and had them springloaded so they'd seem to plow from the back forward.

"Then we had this tree that had fallen across the road, which had to rip the windshield and shear the seat backs off our jeep as it crashes under it, but then break as our T-rex plows through it!" Lantieri says, shaking his head. "The fallen tree was built as a hollow log. It was made out of steel, then skinned with fiberglass and real bark and real limbs and real leaves. We then put a big air-driven piston through the center of it, so that when it was closed, just like a big barrel bolt, the log was sturdy and sound. The jeep actually drove into it at 30 m.p.h. and sheared the windshield off as everyone ducked at the last second, which was a real stunt that Gary Hymes supervised.

"A beat behind that, in the same shot, the T-rex plunges through this log chest-first, which meant that we had to weaken the log and cause it to break itself open so we didn't hurt our creature! The second the jeep went through, I used high-pressure air to pull the piston and create a weak joint in the middle of the tree. The tree was then pulled back from the outside edges using hydraulics, like a swinging barn door, so that at the moment of impact with the T-rex we didn't hurt our star dinosaur.

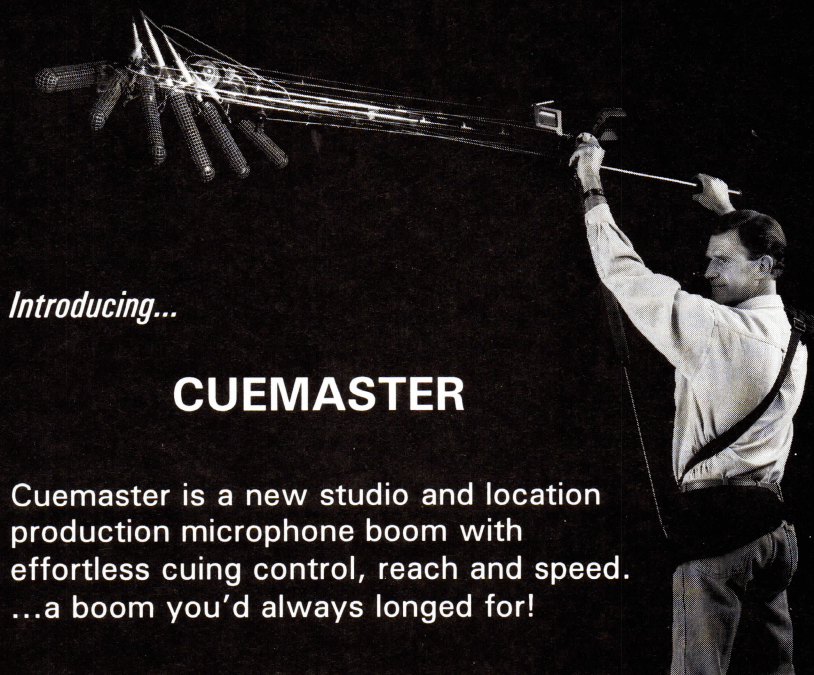
"Lastly," Lantieri says with visible relief, "we kept the shot going

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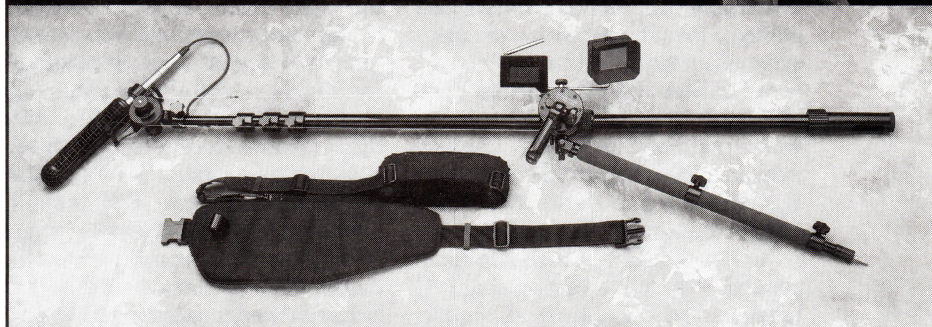
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as the T-rex hits the side of the jeep, denting it and causing it to raise off the ground. Since our 9000-pound animatronic puppet didn't have the strength to do what a real T-rex weighing twenty tons might do, we had to build a jeep that would dent itself on cue and appear to raise off the ground from the impact! We had the entire side of the jeep rigged with pneumatic rams and covered with lead sheets painted to look like the genuine steel skin. The ram, which was extended and welded to the lead skin, was then closed at high pressure at the moment of impact with the T-rex, and it sucked a great big dent in on the side of the jeep. We also had a pneumatic foot hidden behind the rear tire that slammed down into the ground and lifted the jeep off the ground, all of which had to be timed to the movement of the creature. This whole sequence was done in one shot, so you can imagine the amount of timing and cueing required in order for my crew and the stunt people to all hit their marks at the right moment. That was a huge mechanical effect." For added protection, the shot was also done as a motion-control move minus the T-rex, which could then be added later by ILM.

The film's most elaborate mechanical effects set piece again involved the tyrannosaurus rex, who ravages a two-car caravan on a tour of Jurassic Park. The Jurassic Park tour vehicles were supposed to be driverless Ford Explorers on a magnetic track. In reality, they were either radio-controlled or blind-driven vehicles which a driver controlled from underneath the hood. Lantieri had gained a lot of experience with these systems on *Roger Rabbit*, but he had never created a car that would literally crush itself. "The crushable car was a real Ford Explorer," Lantieri explains. "We replaced the door panels we wanted to crush with lightweight aluminum and lead, and we created replaceable, crushable roofs as well. We built a telescoping roll cage inside the headliners of the car, which was what actually pulled the roof down. We also had metal buckling on the side and glass breaking. It was all hydraulically driven, like a big crushpress that we could control with joysticks. We stood right by the camera and Steven would say, 'Crush it a little more... a little more.'

We were trying to give the feeling that this creature's foot was actually on top of the car, crushing it, which meant it couldn't seem like a mechanically clean crush. The car had to rock and crush at the same time, which required some puppeteering. When we shot our pickup scene inside the car with the two kids, we had to be sure that the roll cage was engineered to come to a stop at the right height so it wouldn't harm them, because Steven wanted it to look as if they were almost crushed."

Once the T-rex finishes demolishing the Ford Explorer, he bulldozes it over a cliff, where it lands in the branches of a huge tree. The kids then clamber out of the crushed vehicle as the branches give way, and the car chases them down the tree. The mix of kids and a 3000-pound falling Ford had all the elements of a full-scale real-life disaster, but both Lantieri and Spielberg were fanatical about safety precautions. "The tree was built on Stage 27, which is a pit," Lantieri recalls. "Our tree was 60 feet high, and so detailed that its trunk was even covered with rolled bark that would scrape off as the car slid down it. The tree had to hold the weight of the real Explorer we were going to fly down after it got shoved over a cliff, so you can imagine all the safety precautions we had to go through. We used one of our regular cars with the motor removed, so it was just the frame and body, and we removed or replaced every piece that could break off. The only pieces that broke were ones that we controlled so we knew where they were going to fall. The car was always on a cable, but it still had to fall like it wasn't. It couldn't jerk when it fell. We actually put it into freefall using custom-built hydraulic wedges with electronic braking. That way, we could bring the car from a freefall to a controlled stop in one foot and it wouldn't snap on the cables because of the braking. It was all controlled digitally using a system we built combined with a descender rig that was capable of holding three or four tons. That way, we were able to drop a full-sized car on a limb above people's heads and do close calls. It was a tremendous responsibility, as well as a challenge, to make this look real."

To complicate matters further, the entire effect had to be completely timed out to Spielberg's nod.

"We had hydraulically controlled branches that would break on cue," Lantieri reveals, "so I could build that cinematic tension that Steven loves to create — he's famous for it. After the car hit, the branch slowly started creaking and bent until he nodded, and then we let the branch break and the car fall. Steven knew exactly the length of suspense that he wanted to build. He'd say, 'Let it slip a little... let it slip... now!' and the car had to go right on the money. And it had to be repeatable. After the tree branch broke, we reset and reskinned it. We were all set to go while he waited, or we wouldn't be there the next day. That's part of the joy and challenge of working with someone like Steven."

Lantieri and company also created the usual atmospheric effects — rain, mist and fog — on set and on location, and also took care of details such as dinosaur tracks and park fences. "Fencing!" Lantieri shrieks. "Let me tell you about a simple job, the kind of thing that would just slide by on this movie. When I read the script, the last thing on my mind was fencing! I was thinking, 'My God, the special effects on this movie! Do I really want this job?' But once we got the drawings and they said, 'Okay, just go put some fence up for us,' well, that took months."

And yet, Lantieri concludes, "I'm wondering where I go from here. I hope that having the opportunity to work on this film, with Steven as our fearless leader, wasn't a once-in-a-lifetime opportunity."

Winston concurs, adding: "To me, the most exciting thing about *Jurassic Park* is that these dinosaurs are beautiful, they're real, and everything about their movements and their looks is organic. Some of the finest artists in the world worked for the longest time designing them, creating their look, their texture, and their movement, and the *pièce de résistance* is the fact that they do perform and that they can act. And when they can't do something, that's where ILM and Dennis Muren come in. It'll be a beautiful, seamless mix of technologies so that what you see are living dinosaurs that are almost too real to be real." ▲